High Efficiency Water Heater Ready

California Statewide Utility Codes and Standards Program

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Presentation Overview

- Potential Code Change Proposals
- Federal/Local Regulations
- Market Penetrations
- Technical Feasibility
- Cost Effectiveness
- Proposed Code Language

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Potential Code Change Proposals

- High-efficiency (HE) water heater ready for residential buildings
  - Electrical connection: 120 volt receptacle
  - Vent system: power vent/easy retrofit
  - Condensate disposal: drain line
  - Gas supply: support tankless water heater
- Flue damper – not considered
- Water heater blanket – not effective

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Federal Standards

- Effective: April 16, 2015
- Mandate high-efficiency water heaters:
  - Residential Storage: Condensing for >55 Gal
  - Gas Instantaneous (tankless): Power vent

EF = 0.615

EF = 0.758

Product Class	Standard Level	
Gas-fired Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.675 – (0.0015 x Rated Storage Volume in gallons)	For tanks with a Rated Storage Volume above 55 gallons: EF = 0.8012 – (0.00078 x Rated Storage Volume in gallons)
Electric Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.960 – (0.0003 x Rated Storage Volume in gallons)	For tanks with a Rated Storage Volume above 55 gallons: EF = 2.057 – (0.00113 x Rated Storage Volume in gallons)
Oil-fired Storage	EF = 0.68 – (0.0019 x Rated Storage Volume in gallons)	
Gas-fired Instantaneous	EF = 0.82 – (0.0019 x Rated Storage Volume in gallons)	

EF = 0.82

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Energy Star

ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
Gas Storage (Beginning 9/1/2010)	EF >= 0.67	FHR >= 67 gallons per hour	Warranty >= 6 years on sealed system	ANSI Z21.10.1/ CSA 4.1
Whole-Home Gas Tankless	EF >= 0.82	GPM >= 2.5 over a 77˚F rise	Warranty >= 10 years on heat exchanger and 5 years on parts	ANSI Z21.10.3/ CSA 4.3

- EF 0.67 can be met with improved atmospheric combustions natural draft water heaters

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California Low NOx Requirement

- 22counties, 29 million population - 77% of CA
  - South Coast AQMD
  - BAY AREA AQMD
  - San Joaquin Valley APCD
  - Sacramento Metropolitan AQMD
  - Yolo-Solano AQMD
  - Ventura AQMD
- To meet Low NOx and Energy Star → Power supply
  - Power vent
  - Flue damper
  - Power burner

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DOE Rulemaking Considerations

- What can be expect in 30 years

Gas-fired Storage	Gas-fired Instantaneous
0.59 - Standing Pilot, 1" ins	0.62 - Standing pilot
0.62 - Standing Pilot, 1.5" ins	0.69 - Standing Pilot, Improved HX
0.63 - Standing Pilot, 2" Ins	0.78 - Electronic Ignition, Improved HX
0.64 - Electronic ignition, 1" ins, power vent	0.80 - Electronic Ignition, Power Vent
0.65 - Electronic ignition, 1.5" ins, power vent	0.82 - Electronic Ignition, Power Vent, Improved HX
0.67 - Electronic ignition, 2" ins, power vent	0.84 - Electronic Ignition, Power Vent, Improved HX
0.77 - Condensing, 2" ins, power vent	0.85 - Electronic Ignition, Power Vent, Direct Vent, Improved HX, Low NOx Burner
	0.92 - Electronic Ignition, Power Vent, Direct Vent, Condensing
	0.95 - Electronic Ignition, Power Vent, Direct Vent, Condensing (Max-Tech)

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Market Trend

- CPUC evaluation of IOU 2006-08 new construction programs
  Instantaneous WH: 0% under 1995 the Title 24 → 24% under the 2005 Title 24
- Manufacturer estimate: +10% growth rate for tankless WH*
- DOE prediction – 2015 market shares w/o the new standards
  - AHRI shipment data & Energy Star goals

TABLE IV.24—WATER HEATERS: BASE-CASE ENERGY EFFICIENCY MARKET SHARES*

Gas storage		Electric storage		Oil storage		Gas-fired instantaneous	
EF	Market share (%)	EF	Market share (%)	EF	Market share (%)	EF	Market share (%)
0.59	63.9	0.90	29.8	0.53	0.0	0.62	1.0
0.62	23.4	0.91	16.8	0.54	20.0	0.69	2.9
0.63	1.6	0.92	11.2	0.56	0.0	0.78	1.0
0.64	4.8	0.93	26.1	0.58	0.0	0.80	4.9
0.65	0.0	0.94	7.5	0.60	10.0	0.82	52.4
0.67	5.3	0.95	3.7	0.62	20.0	0.84	1.9
0.77	1.0	2.0	4.0	0.66	25.0	0.85	3.9
		2.2	1.0	0.68	25.0	0.92	20.4
						0.95	11.7
	100%		100%		100%		100%

*The base-case market shares of each product class are estimated in the shipment analysis, as described in chapter 9 of the final rule TSD.

* 2011 ACEEE Hot Water Forum (Mike Parker of A.O. Smith)

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Measure Feasibility

- 120V electrical receptacle near WH
  - Already installed in garages, need to bring close to WH
- Condensate disposal
  - Drain line: building drainage or outside through side wall
  - A neutralizer is needed only a HE water heater is installed
- Flue Vent
  - No flue vent products are certified for all WH
  - Natural draft: B-type
  - Power vent: Category III,IV
- Gas supply: ¾ inch pipe

Appliance Category	Vent Pressure	Condensing
I	Non-Positive	Non-Condensing
II	Non-Positive	Condensing
III	Positive	Non-Condensing
IV	Positive	Condensing

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Cost Effectiveness Analysis Method

- Cost Effectiveness of HE water heater

$$\Delta LCC = Cost\ Premium - PV of\ Energy\ Savings$$

- Cost Savings of HE water heater ready

$$\Delta Total\_Ready\_Cost_{NC} = \Delta Unit\_Ready\_Cost_{NC} \times Annual\_Unit_{NC} \times (1 - e\%)$$

$$\Delta Total\_Avoided\_Cost_{retrofit} = \Delta Unit\_Avoided\_Cost_{retrofit} \times Annual\_Unit_{NC} \times r\%$$

$$\frac{\Delta Total\_Avoided\_Cost_{retrofit}}{\Delta Total\_Ready\_Cost_{NC}} > 1$$

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Gas Water Heater Options

- DOE Rulemaking Supporting Documents (2010$)

Water Heater Options	Energy Factor	Retail Price
Gas-fired Storage		
0.62 - Standing Pilot, 1.5” ins	0.62	$691
0.63 - Standing Pilot, 2” Ins	0.63	$929
0.64 - Electronic ignition, 1” ins, power vent	0.64	$949
0.65 - Electronic ignition, 1.5” ins, power vent	0.65	$981
0.67 - Electronic ignition, 2” ins, power vent	0.67	$1,243
0.77 - Condensing, 2” ins, power vent	0.77	$1,243
Gas Instantaneous		
0.82 - Electronic Ignition, Power Vent, Improved HX	0.82	$1,168
0.84 - Electronic Ignition, Power Vent, Improved HX	0.84	$1,775
0.85 - Electronic Ignition, Power Vent, Direct Vent, Improved HX, Low NOx Burner	0.85	$1,882
0.92 - Electronic Ignition, Power Vent, Direct Vent, Condensing	0.92	$2,047
0.95 - Electronic Ignition, Power Vent, Direct Vent, Condensing (Max-Tech)	0.95	$2,261

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Gas Water Installation Costs

- DOE Rulemaking Supporting Documents
  - Venting: Horizontal install, 12 ft long (typical floor plans from PIER study)

	New Construction	Retrofit Upgrade	Replacement
Basic Installation Total	**$428**	**$487**	**$487**
Putting in Place & Setting Up WH	$233	$233	$233
Water/Gas Piping	$196	$0	$0
Trip Charge/Remove Old Water Heater	$0	$185	$185
Permit & Removal/Disposal Fees	$0	$70	$70
Venting System			
Plastic	$158	$204	$0
Type-B Stainless Steel	$571	n/a	$0
Type-B steel	$482	n/a	$0
Electric Connection	$0	$259	$0
Condensate Disposal			
Drain Connection	$57	$113	$0
Neutralizer Condensate Filter	$86	$86	$86
Condensate Pump	$0	$40	$0
3/4" Gas Supply (incremental cost compared to ½" pipe)	$63	$741	$0

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New Construction LCC

- Baseline, 0.62EF storage water heater
- 30 year gas TDV
  - Storage WH lifetime – 13 years → 2 replacement
  - Tankless WH lifetime – 20 years → 1 replacement

		Climate Zone																
Level	EF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Average
Gas-fired Storage Water Heater																		
S2	0.63	$420	$428	$428	$431	$429	$436	$441	$439	$440	$440	$435	$432	$441	$435	$461	$411	$434
S3	0.64	$309	$321	$322	$327	$323	$334	$342	$339	$342	$341	$333	$328	$343	$333	$375	$294	$332
S4	0.65	$281	$298	$299	$306	$301	$316	$327	$323	$326	$326	$314	$308	$328	$314	$373	$261	$313
S5	0.67	$732	$757	$759	$769	$761	$784	$802	$794	$800	$800	$782	$772	$803	$781	$871	$701	$779
S6	0.77	($134)	($72)	($67)	($42)	($62)	($5)	$38	$20	$34	$32	($11)	($35)	$42	($13)	$207	($209)	($17)
Gas-fired Instantaneous Water Heater																		
I4	0.82 (0.75)	($1,867)	($1,810)	($1,805)	($1,783)	($1,801)	($1,749)	($1,709)	($1,726)	($1,713)	($1,714)	($1,755)	($1,776)	($1,706)	($1,756)	($1,554)	($1,936)	($1,760)
I5	0.84 (0.77)	($1,097)	($1,034)	($1,029)	($1,004)	($1,024)	($967)	($923)	($941)	($927)	($928)	($973)	($996)	($919)	($974)	($752)	($1,174)	($979)
I6	0.85 (0.78)	($1,005)	($939)	($933)	($908)	($928)	($868)	($822)	($841)	($827)	($828)	($875)	($899)	($818)	($876)	($643)	($1,084)	($881)
I7	0.92 (0.85)	($1,192)	($1,108)	($1,101)	($1,068)	($1,095)	($1,017)	($959)	($983)	($964)	($966)	($1,026)	($1,057)	($954)	($1,027)	($730)	($1,294)	($1,034)
I8	0.95 (0.87)	($1,038)	($946)	($939)	($903)	($932)	($848)	($785)	($811)	($791)	($793)	($858)	($891)	($779)	($859)	($536)	($1,149)	($866)

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Cost Savings

- If more than 7.5% of the market upgrade to HE water heaters, net cost savings > 0

	Baseline		New Construction		Retrofit Upgrade	
Venting System	Type-B steel	$482	Type-B steel	$482	Category III or IV (plastic)	$204
Electric Connection	No	$0	Yes	$0	Yes	$259
Condensate Line	No	$0	Drain Connection	$57	Drain Connection & Condensate Pump	$153
Gas Line Upgrade	No (1/2")	$0	Yes (3/4")	$76	Yes (3/4")	$741
Total		$482		$615		$1,357
New Construction Incremental Cost				**$133**		
Retrofit Incremental Cost						**$1,357**

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Compliance Benefits

- Water heating represents 20% to 80% of the TDV energy budget
- We've seen large penetration of instantaneous water heater

Water Heater Options	DHW TDV Reduction	Total TDV Reduction	Incremental Installed Cost
0.77 – Storage: Condensing, 2" ins, power vent	25%	5% - 20%	$350
0.82 – Instantaneous: Electronic Ignition, Power Vent, Improved HX	23%	5% - 18%	$322
0.92 - Electronic Ignition, Power Vent, Direct Vent, Condensing	38%	8% - 30%	$678

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Proposed Code Language

- Section 150(n) - New

(n) Water Heating System.

1. **Gas Water Heater.** Systems using gas or propane water heaters to serve individual dwelling units shall include following components:

A. A 120V electrical receptacle within 3 feet from the water heater without partition walls in between; and

B. A Category III or IV vent, and

C. A condensate drain that meets local jurisdiction requirements, and

D. A gas supply line with a capacity of at least 200,000 Btu/hr.

Exception to B: The building plan includes a vent retrofit plan for future upgrade to a Category III or IV vent. The plan shall include a vent path less than 12 Ft without any interior walls along the path and a side-wall vent location in compliance with the National Fuel Gas Code.

2. **Recirculation Loops Serving Multiple Dwelling Units.** Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 113(c)5.

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Proposed Code Language - AHRI

- Section 150(n)

(n) Water Heating System.

1. **Gas Water Heater.** Systems using gas or propane water heaters to serve individual dwelling units shall include following components:

   A. …

   B. For gas water heaters using a natural draft venting system, the building plan shall include a vent retrofit plan identifying a horizontal vent path less than 12 feet without any interior walls along the path and a side-wall vent location in compliance with the National Fuel Gas Code., and

   C. …

   D. …

2. **Recirculation Loops Serving Multiple Dwelling Units.** Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 113(c)5.

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QUESTIONS & COMMENTS

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